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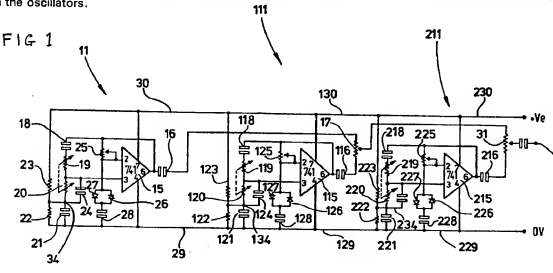
(54) Audio and video recording technique

(57) A method of producing recordings of an information signal which cannot be re-recorded on a tape recorder without unacceptable contamination by beat frequencies generated from signals recorded, together with the information signal, on the genuine recording.

This is achieved by mixing, with the desired information signal, a number of signals above the audio frequency range which, upon playback, interfere with one another to produce beat frequencies in the vicinity of the bias frequency of a tape recorder. These beat frequencies interfere with the bias frequency and produce fresh subtractive beat frequencies which are in the audio frequency range.

Apparatus for producing the contaminating signals comprises a set of oscillators (11, 111, 211) the output signals from which are combined via variable resistors at (17) and (31) to produce an output signal which contains not only the original oscillators signals but also beat frequencies at the sum and difference of all the oscillators.

FIG 1



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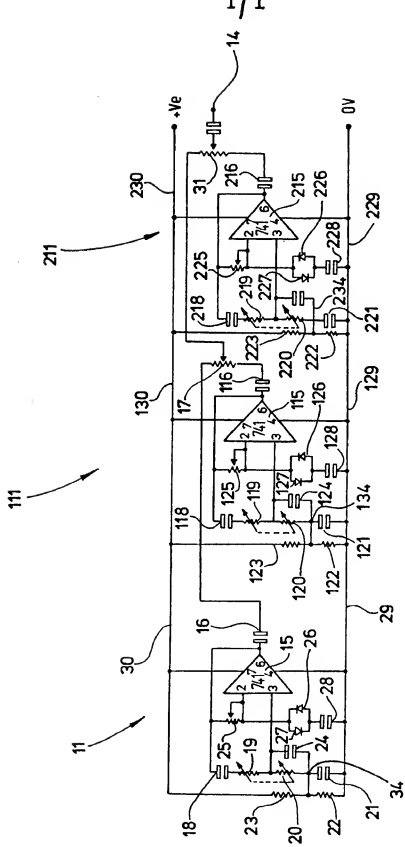

FIG 1

SPECIFICATION

Audio and video recording technique

The present invention relates generally to techniques for recording audio and video signals, and also comprehends apparatus for making recordings employing such techniques, and to recordings so made.

Various techniques for producing audio and video recordings are known: these include the production of grooved discs to be transcribed by apparatus including a stylus running in the grooves, magnetic tape recordings, magnetic disc recordings and others including holgraphic techniques. A common feature of all recordings is the conversion of the audio and/or video signal into electrical signals used, in effect, as a transfer medium between the acoustic and/or optical signals and the particular recording technique used. As far as audio signals are concerned, these are commonly recorded on grooved discs or magnetic tape, whereas the greater signal density required for optical signals has required special magnetic tape recording techniques and has resulted recently in the introduction of laser holgrams, the so-called laser discs, which store recorded information optically.

A common problem with grooved disc or magnetic tape recordings is the ease with which the electrical signals generated thereby upon replay can be re-recorded on magnetic tape to produce unauthorised recordings. This unauthorised or "pirate" re-recording of recorded works has led to considerable loss of income for recording companies, and, particularly in the case of video tape recordings, has been the subject of considerable study, both from a legal point of view in attempting to make pirate re-recordings more difficult or at least the subject of greater penalties than at present, and clearly illegal, and also from a technical point of view with attempts at producing recordings which cannot be re-recorded on magnetic tape in an unauthorised manner. The present invention relates to the technical solution of this problem.

It is known that certain frequency modulated radio signals produce, upon recording with magnetic tape recording equipment, unwanted and disturbing audio signals in the form of a constant beat frequency range tone. This results from interference between the bias frequency signal of the bias oscillator, a portion of which is fed to the record head of a magnetic tape recorder during recording, and the pilot frequency of the FM radio signal which is outside the audible range. Unfortunately, it is not possible simply to record such a high frequency signal onto a grooved disc gramophone record or a tape record (hereinafter referred to as a tape cassette although reel-to-reel tape is not to be considered as excluded thereby) since in the case of a gramophone the electro-mechanical equipment is incapable of reproducing signals at such high frequency and in the case of a tape recording the high frequency signal would itself produce a disturbing interference signal with the bias frequency.

According to the present invention, therefore, this problem is overcome in an audio or video recording (this term being understood to incorporate recordings made in any form for reproduction on equipment employing electrical signals as a transcription medium) which, in addition to the information signal, contains a recording of a plurality of additional signals at frequencies related to one another in such a way that they interact to produce an additive beat frequency signal at, or in the close vicinity of that of the bias frequency oscillator of magnetic tape recording equipment, such that the beat frequency signal thus generated will itself interfere with the bias frequency of the tape recorder, with which the signal intended to be recorded is mixed during recording, to produce a subtractive beat frequency in the audible range.

Thus, the interfering signal which interacts with the bias frequency of the oscillator upon re-recording a gramophone or tape recording is generated from lower frequency signals present on the recording itself. These lower frequency signals can still be at sufficiently high frequency to be outside the audible range, say above about 17 kHz, whereas the subtractive beat frequency generated by interference of the additive beat frequency of the recorded signals and the bias frequency of the oscillator can be in a part of the spectrum which is most noticeable to the human ear, say in the region of a few thousand Hz.

Various techniques can be employed to make it difficult to filter out the recorded additional signals. First, the absolute values of the said additional signals may be varied in a regular or irregular manner above and/or below the nominal frequency. Any attempt to filter the additional signals would thus require a very broad band filter, which would also remove the required information signal from the original recording in the re-recording thereby reducing its reproduction quality and, hopefully, making it unacceptably poor.

In order to make the presence of the additional signals as unobtrusive as possible, these may have amplitude envelopes of smoothly varying form increasing from zero to their maximum amplitude and back to zero in a continuously varying manner without discrete amplitude steps.

Furthermore, the difference between the absolute values of the frequencies of the said additional signals may be varied temporally so that the eventual audible beat frequency generated thereby will vary and this will increase the obtrusive effect and also enable variations in the absolute value of the bias frequency of

the bias oscillator from one recording apparatus to another to be accommodated. In the above discussion it has been assumed that the bias frequency of the oscillator in all recording equipment is exactly the same. In practice this is not the case and although the majority of tape recorders employ bias oscillators having a frequency in the range 50–55 kHz there are some which fall outside this range. However, by varying the difference between the absolute values of the frequencies of the additional signals in the recording the value of the additive beat frequency generated thereby will vary above and below the precise value of the bias frequency in any one tape recorder. This may mean that interference beats between the bias frequency and the additive beat frequency of the recorded additional signal will not be pesent at all times, but the appearance and disappearance of such obtrusive signals in a short period of time (and it is envisaged that the cycle time may be a matter of seconds or even fractions of a second can add to the annoyance value thereby spoiling the recording more securely. For exemple, if the actual frequency of the subtractive beats between the bias frequency oscillator signal and the additive beat frequency of two or more additional signals recorded with the information signal of an original recording is in the region of 2.5 kHz and the difference between the absolute values of the frequencies of the additionel signels is varied between maxima and minima at a rate of 15 Hz, then the eventual beat signal will be pulsed with a pulse repetition frequency of 15 Hz, which is a particularly unnoying signal format and thus of considerable benefit for the present purpose.

The present invention also comprehends e method of recording information signals (as used in this specification the term "information signals" will be understood to refer to any form of signal, whether an audio or video signal of music, speech or otherwise, which may be desired to be recorded), in which a plurality of additional signals are introduced into the desired information signal to be recorded therewith, the said additional signals having a constant frequency or a temporal frequency variation within a predetermined range, and being spaced from one another by a frequency or frequency range selected so that at least in some parts of the range the said plurality of additional signals interfere with one another to produce additive beat frequencies sufficiently close to the bias frequency of a tape recorder as to produce subtractive beat frequencies in the audible range.

This method is effective because of the conventional technique of introducing a proportion of the bias frequency signal into the recording path of the information signal, normally at the recording head itself.

The present invention further comprehends apparatus for producing recordings, such as grooved disc or magnetic tape recordings, including means for generating additional signals and for mixing them with the information signal intended to be recorded, the relative values of the additional signals being such that upon reproduction they interfere to produce an additive beat frequency signal sufficiently close to the frequency of the bias oscillator of magnetic tape recording equipment as to produce a subtractive beat frequency in the audible range, which is recorded on the magnetic tape for subsequent reproduction with the information signal.

Examples of the signals which may be employed are as follows.A gramophone record including a music signal was also recorded with additional signals at 17.5, 17.505, and 17.51 kHz. These signals are all at the upper end of the audible frequency spectrum and would be unnoticeable to all except very young listeners whose audible range generelly extends higher than that of adults. Upon trenciption of the gramophone record, the music signal is reproduced in the usual way and the additional signals likewise, with the exception that these signals interfere with one another to produce additive beat frequencies at 52.515 kHz, 35.005 kHz and 35.010 kHz as well as 35.015 kHz. The subtractive beat frequencies are at 15 Hz and are effectively negligible in that they are outside the range of reproduction by the transcription equipment with the exception of the 15 Hz signal the effect of which is not great due to the fact that the energy content of this subtractive beat frequency signal is low.

If the gramophone record is used to generate an input signal to a tape recorder, on the other hand, the electrical signal so produced is fed to a recorder head which, as mentioned above, is conventionally also supplied with a proportion of the bias oscillator signal at a frequency in the region of 50–55 kHz.

For the purpose of this example, a frequency of 55 kHz of the bias oscillator is assumed. The additive interference beat frequencies between the bias frequency signal and the mixed signals generated by the additional signals on the gramophone record lie well outside the audio spectrum, being in excess of 100 kHz. The subtractive beat frequencies between, for example, the 52.515 kHz signal and the 55 kHz signal is at 2.485 kHz which is extremely obtrusive.

It is important that the oscillators used to generate the additional signals for recording with the information signal on the original recording maintain a constant separation between their individual frequencies within about 20 per cent, and as mentioned above the difference can be varied within this range in order to accommodate differences in the actual bias frequency of different tape recorders.

Thus, by recording additional signals outside

the audible spectrum but within the range covered by the equipment it is possible to generate a "spoiler" signal upon transcription which is itself outside the audio spectrum, and outside the normal transciption range.

One embodiment of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawing which is a schematic circuit diagram illustrating a signal generating circuit for producing additional signals to be added to audio or video signals for recording.

Referring now to the drawing, the circuit illustrated comprises a set of three oscillators generally indicated 11, 111 and 211.The oscillator 11 produces a high frequency output in the range of 8 Khz to 20 KHz whilst the oscillators 111 and 211 respectively produce different relatively low frequency output signals in the region of 4 Hz and 8 Hz respectively. The output signal from the multiple oscillator circuit is taken from a terminal 14 and is intended to be supplied to a recorder or to a mixer for mixing with a music or other information signal to be recorded.

The oscillator 11 comprises an amplifier 15 the output of which is fed via a capacitor 16 to a variable resister 17, and is also fed back to a capacitor 18 connected in series with two ganged variable resisters 19, 20 which are connected to ground via a capacitor 21 and a resister 22, and to the positive supply voltage via a resister 23 which, together with a resister 22, constitutes a voltage divider biasing the circuit node 24 at the junction between the variable resister 20 and the capacitor 21. This circuit node 34 is also connected by a capacitor 24 to one input of the amplifier 15 and to the junction between the variable resistors 19 and 20. The other input of the amplifier 15 is supplied via a variable resister 25 in the feed back circuit of the amplifier, which is grounded via a pair of diodes 26, 27 in anti parallel and a capacitor 28 connected to the ground line 29.

The oscillator 111 has basically the same configuration, and the circuit components are identified with the same reference numerals raised by 100. The values of the circuit components are varied in order to determine the frequency of the oscillator. The cursor of the variable resistor 17 is connected to another variable resistor 31 at the output of the third oscillator 211 which, like the second oscillator 111 has basically the same configuration as the high frequency oscillator 11, with circuit components having different values to determine the low frequency oscillation. The low frequency oscillators 111 and 211 both have only trimming adjustments to fine tune the low frequencies whilst the ganged variable resistors 19, 20 of the high frequency oscillator 11 permit a frequency adjustment and therefore a variable output from the terminal 14. Because of this construction the beat frequencies in the output signal are constant in separation despite any variations in the absolute value of these beat frequencies effected by varying the frequency of the high frequency oscillator 11.

In effect, the variable high frequency oscillator 11 generates the basic high frequency audio signal which is then modulated by the outputs of the other two oscillators 111, 211 to generate the constituents of the ultimate spoiler signal to be added to the music or other information signal to be recorded.

As explained above, the use of a beat frequency oscillator of this type ensures that the separation value between the resulting beat frequency signals is maintained regardless of any variation in the basic high frequency oscillator signal. The beat frequencies at the output terminal 14 will thus comprise those generated by the addition of the signals from the oscillator 11 and the oscillator 111, the signal from the oscillator 11 and the oscillator 211, th subtraction of the signal from the oscillator 111 from the high frequency signal from the oscillator 11, the subtraction of the signal from the oscillator 211 from the high frequency oscillator 11, in addition to the high frequency signal from the oscillator 11 itself.There will also be lower beat frequencies from the sum of the signals from the oscillators 111 and 211 as well as the individual signals from the oscillators 111 and 211 themselves, but these are filtered out at the mixer stage.

For example, if the oscillator 11 produces an output signal at 18 Khz and the oscillators 111 and 211 produce signals at 4 Hz and 8 Hz respectively, the output signal will contain components at 1800 Hz, 17996 Hz, 18004 Hz, 17992 Hz and 18008 Hz. Now, supposing that the genuine recording is reproduced and an attempt made to make a "pirate" recording from it. The lower frequencies maybe disregarded as they will be automatically filtered out of the system before reaching the pirate tape's flux, so that the only signals of significance are the five wave forms lying around the 18 Khz level. On presentation to the tape recorder's circuit these are variously summed to give 36 Khz, 54 Khz, 72 Khz and 90 Khz (as well as the original 18 Khz of course). In this way, if the tape recorder has a bias frequency ranging up to 100 Khz or slightly more, the recording made thereby will be vulnerable to contamination by the beat frequencies as mentioned above.

CLAIMS

1. An audio or video recording which, in addition to the information signal, contains a recording of a plurality of additional signals at frequencies related to one another in such a way that they interfere with one another to produce a beat frequency signal at or in the vicinity of that of the bias frequency oscillator

of magnetic tape recording equipment, such that the beat frequency thus generated will itself beat to produce a subtractive beat frequency in the audible range upon reproduction of a magnetic tape recording made from a reproduction of the original recording.

2. An audio or video recording as claimed in Claim 1, in which the absolute values of the said plurality of additional signals are varied in a regular or irregular manner above and/or below the nominal frequency.

3. An audio or video recording as claimed in Claim 1 or Claim 2, in which the difference between the absolute values of the frequencies of the said additional signals is varied temporally.

4. An audio or video recording as claimed in any of Claims 1 to 3, in which the said additional signals have smoothly varying amplitude envelopes.

5. An audio or video recording as claimed in any of the preceding claims, in which the variations in the said additional signals and/or the presence of the additional signals, is related to the information signals such that the said additional signals are reduced and/or absent in coincidence with a reduction in the volume, or ebsence of, the information signals.

6. A method of recording information signals in which e plurality of additionel signals are introduced into the desired information signal to be recorded therewith, the said additional signals having a constant frequency or a temporal frequency variation within a predetermined range, and being speced from one another by a frequency or frequency range selected so that at least in some parts of the range the said plurality of additional signals interfere with one another to produce additive beat frequencies sufficiently close to the bias frequency of a tape recorder as to produce subtractive beat frequencies in the audible range.

7. A method as claimed in Claim 6, in which the absolute values of the said additional signals are varied (their separation remaining the same) so that interference with the bias frequency signal takes place at an irregular temporal spacing in the reproduced signal.

8. A method as claimed in Claim 6 in which the differences between the frequencies of the additional signals are varied temporally to cause intermittent interference in the reproduced signal.

9. A method as claimed in any of Claims 6 to 8, in which both the absolute values of the frequencies and the differences between the frequencies of the additional signals are varied temporally.

10. A method of recording information signals as claimed in any of Claims 6 to 9, in which the said additional signals are varied in synchronism with information signals whereby to mask the presence of the additional signals in the original recording.

11. A method as claimed in any of Claims 6 to 10, in which the said additional signals are at frequencies or within frequency ranges such as to generate subtractive beat frequencies with the bias oscillator at a frequency in the region of 15 Hz.

12. A method of recording information signals in which at least one additional signel outside the audible range is also recorded, together with required information signal, the frequency of the said additional signal being such that if the combined recorded signals are re-recorded on magnetic tape recording equipment the additional signal and the bias frequency signal generated by the tape recording equipment interacts to form beats at an audible frequency.

13. An audio recording in which the recorded signal is constituted by two parts, the first part comprising the signals representing the desired information intended to be reproduced by the reproduction equipment and the second comprises a spoiler signal at a frequency such as will interact with the bias oscilletor frequency to produce beats at an audible frequency if recorded and played back on a tape recorder.

14. An audio or video recording substantially as hereinbefore described with reference to the accompanying drawings.

15. A method of recording Information signals substantially as hereinbefore described with reference to the accompanying drawings.

16. Apperatus for producing recordings, such as grooved disc of magnetic tape recordings including means for generating additional signals and for mixing them with the information signal intended to be recorded, the relative values of the additional signals being such that upon reproduction they interfere to produce an additive beat frequency signal, sufficiently close to the frequency of the bias oscillator of magnetic tape recording equipment as to produce a subtractive beat frequency in the audible range, which is recorded on the magnetic tepe for subsequent reproduction with the information signal.

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